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## **Paediatric COVID-19 admissions in a region with open schools during the two first months of the pandemic**

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According to the United Nations Educational, Science and Cultural Organization, 194 countries had implemented country-wide school closures by April 1<sup>st</sup> 2020 in an effort to combat the COVID-19 pandemic. It's estimated that those closures affected 91.3% of students across the globe. However, Sweden adopted a different approach to the strict lockdowns imposed elsewhere and day care centres and schools for children up to 15 years of age remained open. The strategy decision to shift schools to distance learning only for children aged 16 years and older was influenced by multiple factors, including the potential impact on school closures on the availability of the healthcare work force, the increasing evidence of mainly mild infections among children and the potential negative consequences of school closures for younger children.

While it appears that most children get mild symptoms if they become infected with the Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2) (1), there have been concerns that they may present with high viral loads and contribute to asymptomatic transmission (2). In addition, the number of admissions could exceed the available paediatric hospital care resources (3). Because many Swedish schools have remained open during the pandemic, there is a unique opportunity to assess the impact of this strategy on the incidence and severity of paediatric admissions.

We carried out a two-month review of paediatric admissions aged 0-17 years who tested positive for SARS-CoV-2 in the Stockholm region, where approximately 514,000 (24%) of all Swedish children live. This covered 13 March, when local transmission was announced, until 14 May. We included children of all age groups to allow for comparison of admissions between children who remained in school and teenagers who were affected by school closures. During the study period, a nasopharyngeal sample was collected from close to all paediatric hospital admissions, regardless of why they had been hospitalised, and these were analysed using real-time reverse transcriptase-polymerase chain reaction assays for the SARS-CoV-2 virus. The patient files were reviewed to identify children who were positive for the virus and to collect data on their background characteristic, the symptoms they presented with, any concurrent illnesses and their outcomes. Ethical approval to conduct the study was obtained from the Central Ethical Research Board in Sweden (EPM #2020-02487) and a waiver of informed consent was provided because of the minimal risk of the study.

A total of 63 admitted children aged 0-17 years tested positive for SARS-CoV-2 during the study period. Thirty had a primary COVID -19 diagnosis, corresponding to 0.7% of all admissions due to COVID -19 in the region. Fourteen children were admitted with another concurrent illness and

19 children were incidentally found to be SARS-CoV-2-positive, i.e. the reason for their admission was a non-infectious cause. The cumulative incidence for hospitalization with a non-incidental diagnosis of COVID-19 among children was nine per 100,000 children. This compares to 230/100,000 hospitalized and 99/100,000 deaths due to Covid-19 amongst the adult population in Stockholm ( $n \approx 1.84$  million) during the same time period.

Table 1 provides an overview of the characteristics of the 63 children. This shows that 39/63 (62%) presented with fever and 32/63 (51%) had respiratory symptoms. We found that four children (6%) required oxygen treatment and one patient with immunosuppression was admitted for intensive care but was never intubated. Infants represented more than half of all symptomatic admissions (16/30, 53%) whereas the proportion of all SARS-CoV-2 positive admitted children aged 16-18 (10/63, 16%), for whom schools have been operating on distance, were similar to proportions of children aged 1-5 years (11/63, 17%).

Hyperinflammation occurred in one child who has recovered well on follow-up assessments. One infant with a severe underlying condition arrived at the hospital with cardiac arrest and died after a short history of gastrointestinal illness. The child subsequently tested positive for SARS-CoV-2. As three other pathogens were also identified in post-mortem samples - *Streptococcus salivarius* and *Staphylococcus aureus* in blood culture and *Klebsiella pneumoniae* in nasopharyngeal swab - it is unclear to what extent the SARS-CoV-2-infection affected the outcome of this child.

Paediatric admissions accounted for a minor part of the total admissions due to COVID-19 as a primary diagnosis during the first two months of the pandemic in Stockholm (30/4347, 0.7%). In line with previous research, most children with a primary diagnosis of COVID-19 were less than one year of age and fever and respiratory symptoms were common, but not universal, symptoms (4).

Overall, our results point toward a low incidence of severe illness due to COVID-19 among Swedish children, even though day care centres and primary schools remained open. This suggests that the Swedish strategy did not aggravate the course of the pandemic for children in Sweden, when it is compared to countries with stricter lockdown measures (4). However, the impact on the open school strategy on the overall transmission of SARS-CoV-2 within the Swedish society is unknown. The potential degree of SARS-CoV-2 transmission from children to the adults and its consequences for adult hospitalisations and deaths is beyond the scope of this report.

Continued assessment of hyperinflammation and other late-onset complications in children is warranted, given that symptoms may present weeks after the acute infection. Results should be considered in relation to the limited evidence regarding the overall benefit of school closures and the potential risks that school closures pose for children who are already vulnerable (5).

#### CONFLICTS OF INTEREST

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## REFERENCES

1. Ludvigsson JF. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. *Acta Paediatr.* 2020;109(6):1088-95.
2. Jones TC, Muhlemann B, Talitha. V, Zuchowski M, Hofmann J, Stein A, et al. An analysis of SARS-CoV-2 viral load by patient age. 2020.
3. Pathak EB, Salemi JL, Sobers N, Menard J, Hambleton IR. COVID-19 in Children in the United States: Intensive Care Admissions, Estimated Total Infected, and Projected Numbers of Severe Pediatric Cases in 2020. *J Public Health Manag Pract.* 2020.
4. Zachariah P, Johnson CL, Halabi KC, Ahn D, Sen AI, Fischer A, et al. Epidemiology, Clinical Features, and Disease Severity in Patients With Coronavirus Disease 2019 (COVID-19) in a Children's Hospital in New York City, New York. *JAMA Pediatr.* 2020:e202430.
5. Van Lancker W, Parolin Z. COVID-19, school closures, and child poverty: a social crisis in the making. *Lancet Public Health.* 2020;5(5):e243-e4.

**Table 1. Characteristics of paediatric admissions in Stockholm Region, Sweden, from 13 March to 14 May 2020 based on COVID-19 diagnosis categories**

	Number (%)			
	Primary diagnosis (n= 30)	Secondary diagnosis (n=14)	Incidental diagnosis (n=19)	Total COVID-19 cases (N=63)
<b>Age</b>				
<1 year	16 (53)	4 (29)	1 (5)	21 (33)
1 - 5 years	4 (13)	2 (14)	5 (26)	11 (17)
6- 15 years	6 (20)	6 (43)	9 (47)	21 (33)
16- 18 years	4 (13)	2 (14)	4 (21)	10 (16)
<b>Median age, years</b>	0.5	7.6	9.4	4.7
<b>Gender</b>				
Female	9 (30)	8 (57)	9 (47)	26 (41)
<b>Chronic illness</b>	9 (30)	5 (36)	11 (58)	25 (40)
Asthma	3 (10)	0	0	3 (5)
Haematological/oncological	3 (10)	1 (7)	7 (37)	11 (17)
Neurological and multiple	3 (10)	2 (14)	2 (11)	7 (11)
Other	0	2 (14)	2 (11)	4 (6)
<b>Symptom presentation</b>				
Asymptomatic	0	1 (7)	10 (53)	11 (17)
Symptomatic	30 (100)	13 (93)	9 (47)	52 (83)
Fever	27 (90)	7 (50)	5 (26)	39 (62)
Respiratory	22 (73)	4 (29)	6 (32)	32 (51)
Gastrointestinal	9 (30)	6 (43)	1 (5)	16 (25)
Hyperinflammation <sup>a</sup>	1 (3)	0	0	1 (2)

Seizures	3 (10)	2 (14)	0	5 (8)
<b>Treatment</b>				
Oxygen	4 (13)	0	0	4 (6)
Non-invasive respiratory support	3 (10)	0	0	3 (5)
Intensive Care	1 (3)	0	0	1 (2)
<b>Outcome</b>				
Recovered	30 (100)	13 (93)	19 (100)	62 (98)
Deaths	0	1 (7)	0	1 (2)

<sup>a</sup> Two children with hyperinflammation were admitted during this period: one was only positive for SARS-CoV-2 antibodies and is not included in this Table.